CRYSTAL-FACE

Thin Cirrus Properties from Space using the MISR Multi-angle Research Aerosol Retrieval

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Jennifer Comstock
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& the MISR Team

Validating MISR Sensitivity to Thin CIRRUS

MISR Team Goals for CRYSTAL-FACE Campaign Summer 2002 IFC

Two algorithm ideas for characterizing **optically thin**, **uniform cirrus**:

(1) **Band-Difference-Angular-Signature** (BDAS) cloud detection algorithm (Wilson, DiGirolamo)

- Uses multi-angle **blue and near-IR** MISR bands
- **Detects scattering layers** high above most Rayleigh scattering
- Might use BDAS detection as a **trigger** for the aerosol retrieval

(2) Include a **cirrus component** in Standard aerosol retrieval algorithm (Kahn)

- Uses multi-angle **red and near-IR** bands over dark water
(4 bands over land)
- Derives information about **aerosol amount and type**

Validating MISR Sensitivity to Thin CIRRUS

CRYSTAL-FACE Campaign, Summer 2002 IFC

BDAS Cirrus Detection + Aerosol/Cirrus Retrieval

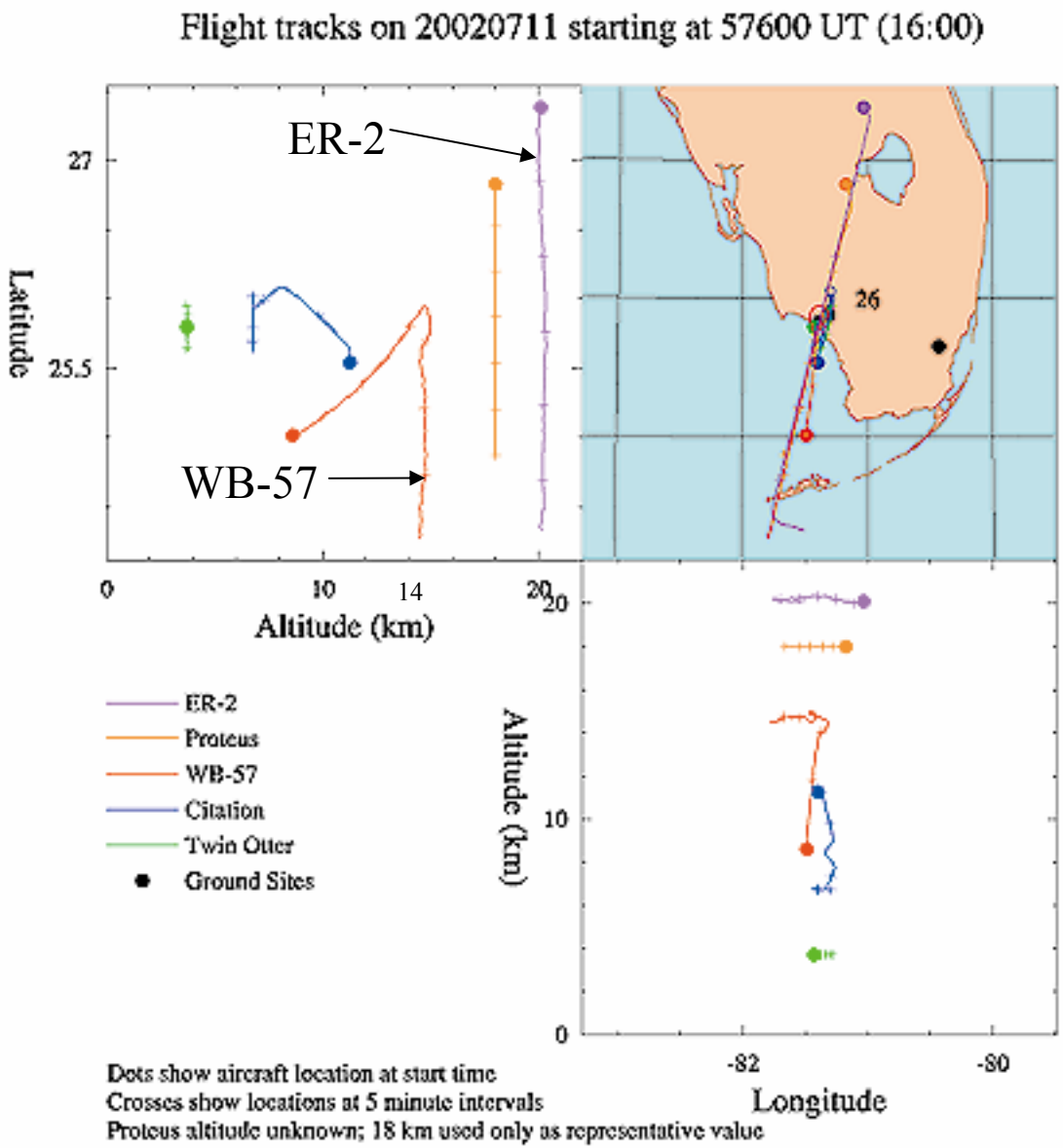
GOALS:

- **Test both algorithms** against simultaneous in situ validation data
- **Quantify the sensitivity** to cirrus of each algorithm, under natural conditions

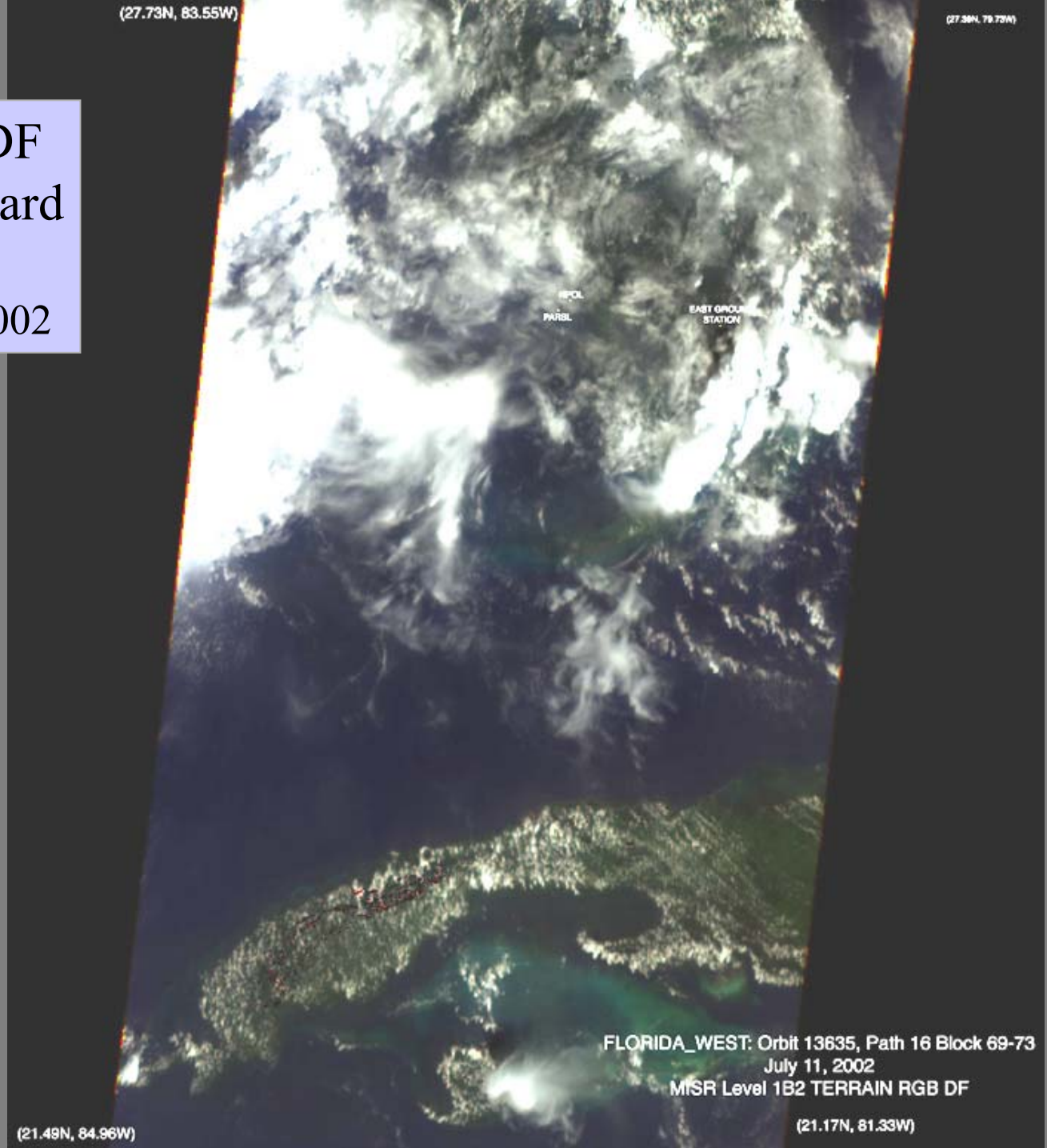
MISR coverage for the CRYSTAL-FACE Campaign

July 1- July 31, 2002

Date	UTC	Target	Orbit	Path/Block
July 04 2002	185_16:05:42	Crystal_West	13533	15/71
July 06 2002	187_15:53:21	Crystal_East	13562	13/71
July 09 2002	190_16:26:05	Crystal_SW	13606	18/76
July 11 2002	192_16:11:47	Crystal_West	13635	16/71
July 13 2002	194_15:59:25	Crystal_East	13664	14/71
July 18 2002	199_16:19:56	Crystal_SW	13737	17/76
July 20 2002	201_16:05:38	Crystal_West	13766	15/71
July 22 2002	203_15:53:15	Crystal_East	13795	13/71
July 25 2002	206_16:26:05	Crystal_SW	13839	18/76
July 27 2002	208_16:11:36	Crystal_West	13868	16/71
July 29 2002	210_15:59:12	Crystal_East	13897	14/71

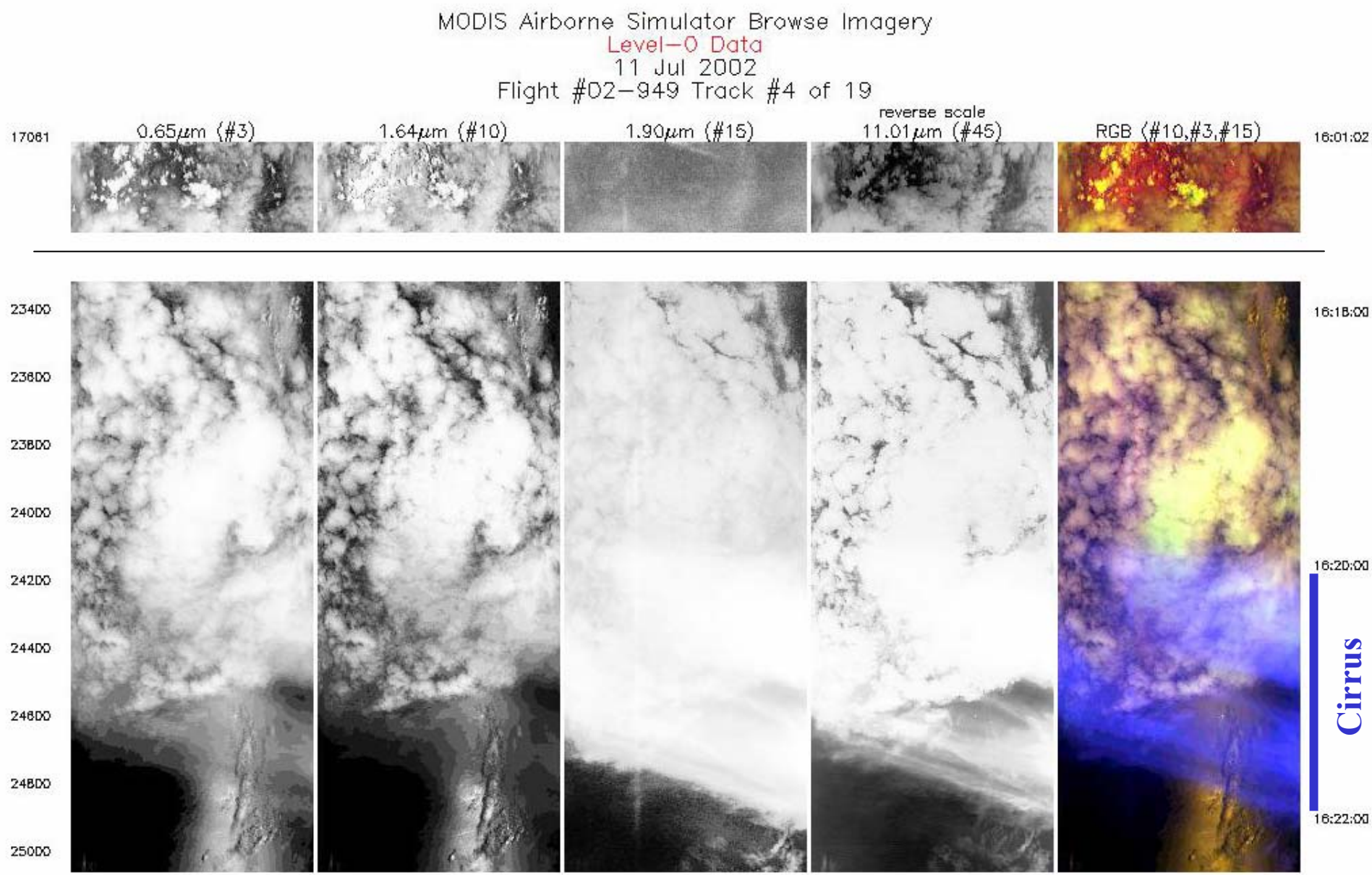

Flight tracks on 20020711 starting at 57600 UT (16:00)
ER-2
WB-57
27
25.5
Latitude
26
0
10
14
20
Altitude (km)
20
10
0
Altitude (km)
-82
-80
Longitude
ER-2
Proteus
WB-57
Citation
Twin Otter
Ground Sites
Dots show aircraft location at start time
Crosses show locations at 5 minute intervals
Proteus altitude unknown; 18 km used only as representative value

MISR DF
70° Forward
View
July 11, 2002

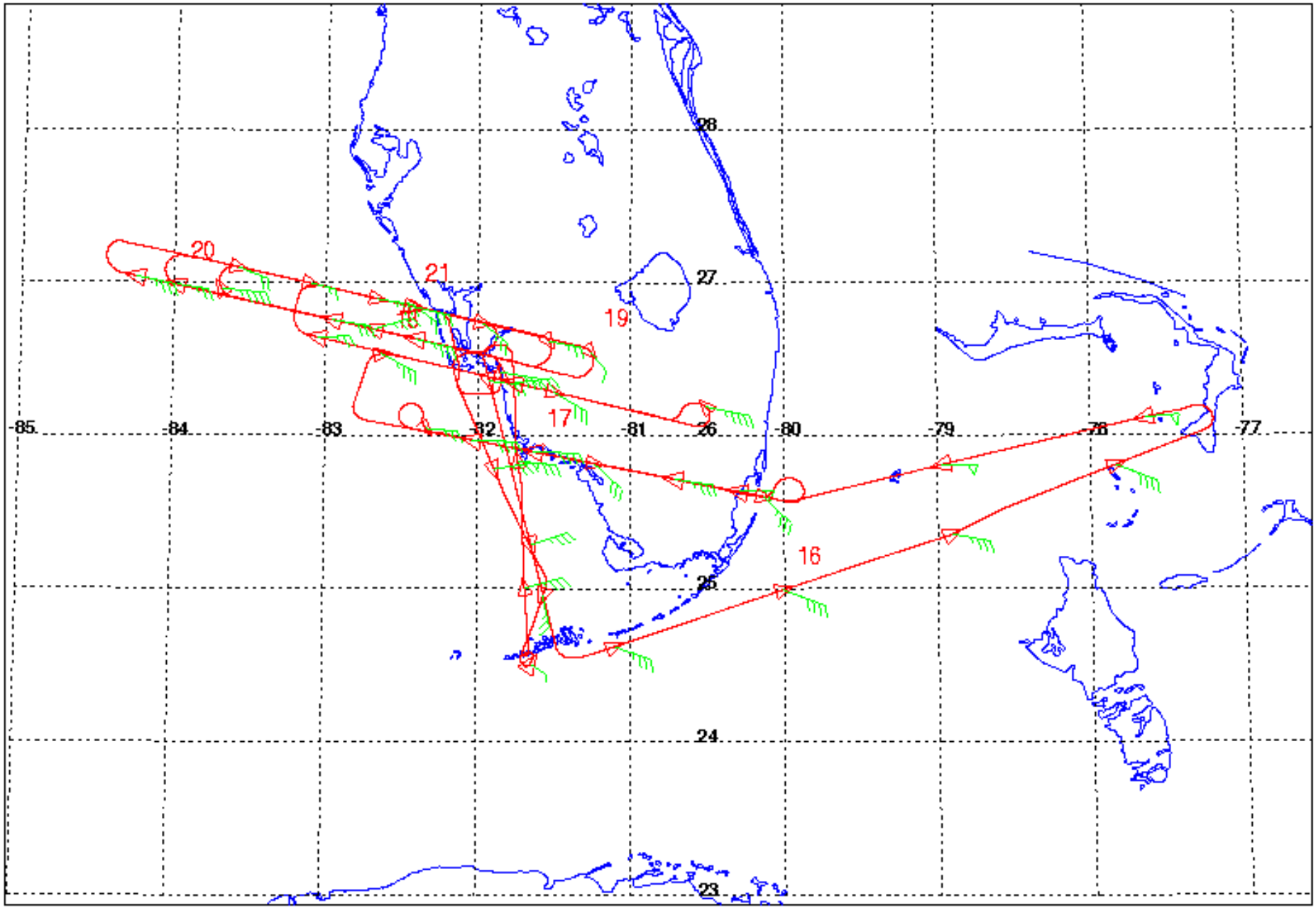


MAS: MODIS Airborne Simulator - ER-2

July 11, 2002

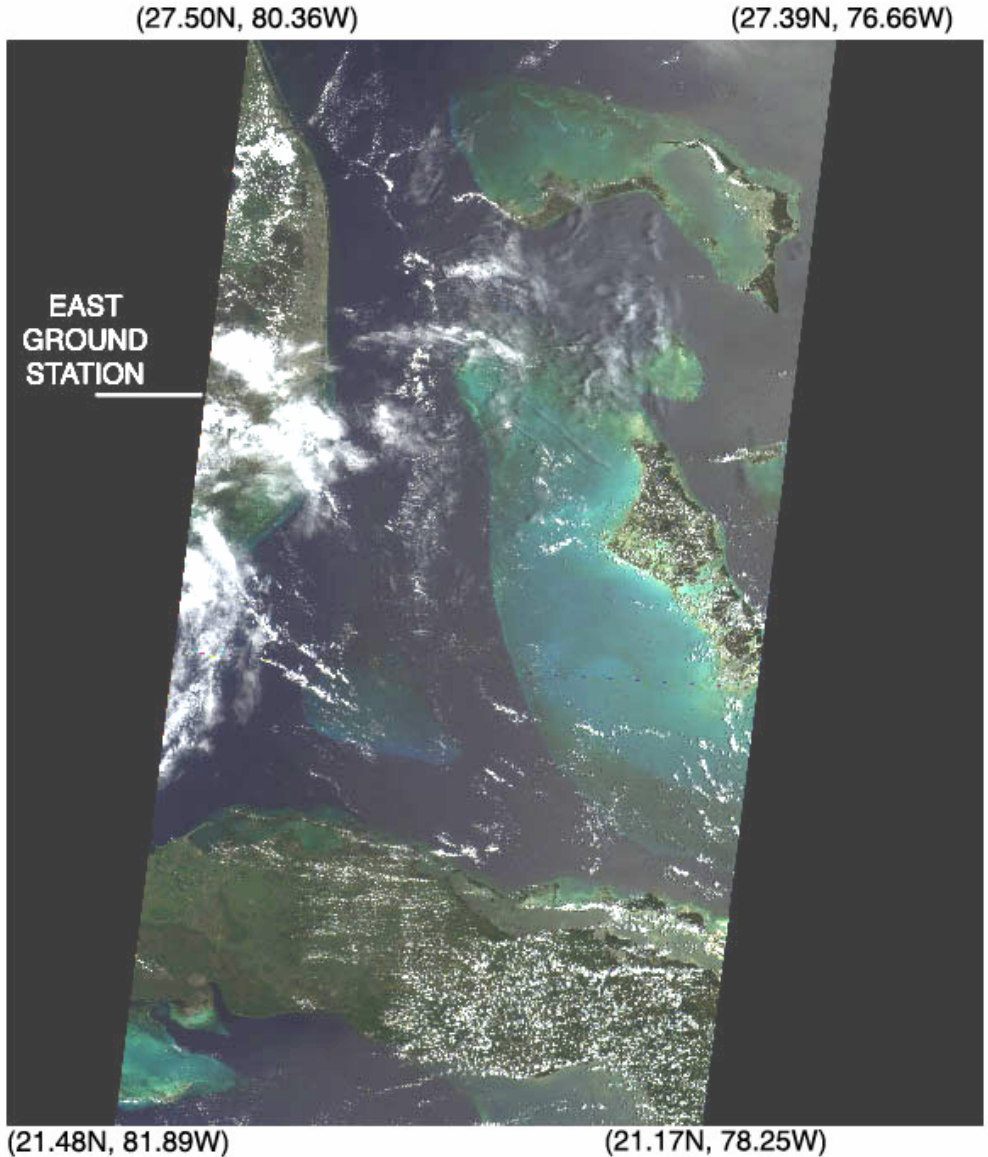


NASA DFRC ER-2 Navigation Recorder Data Flight Date: Jul 29,2002 Sortie: 02-956

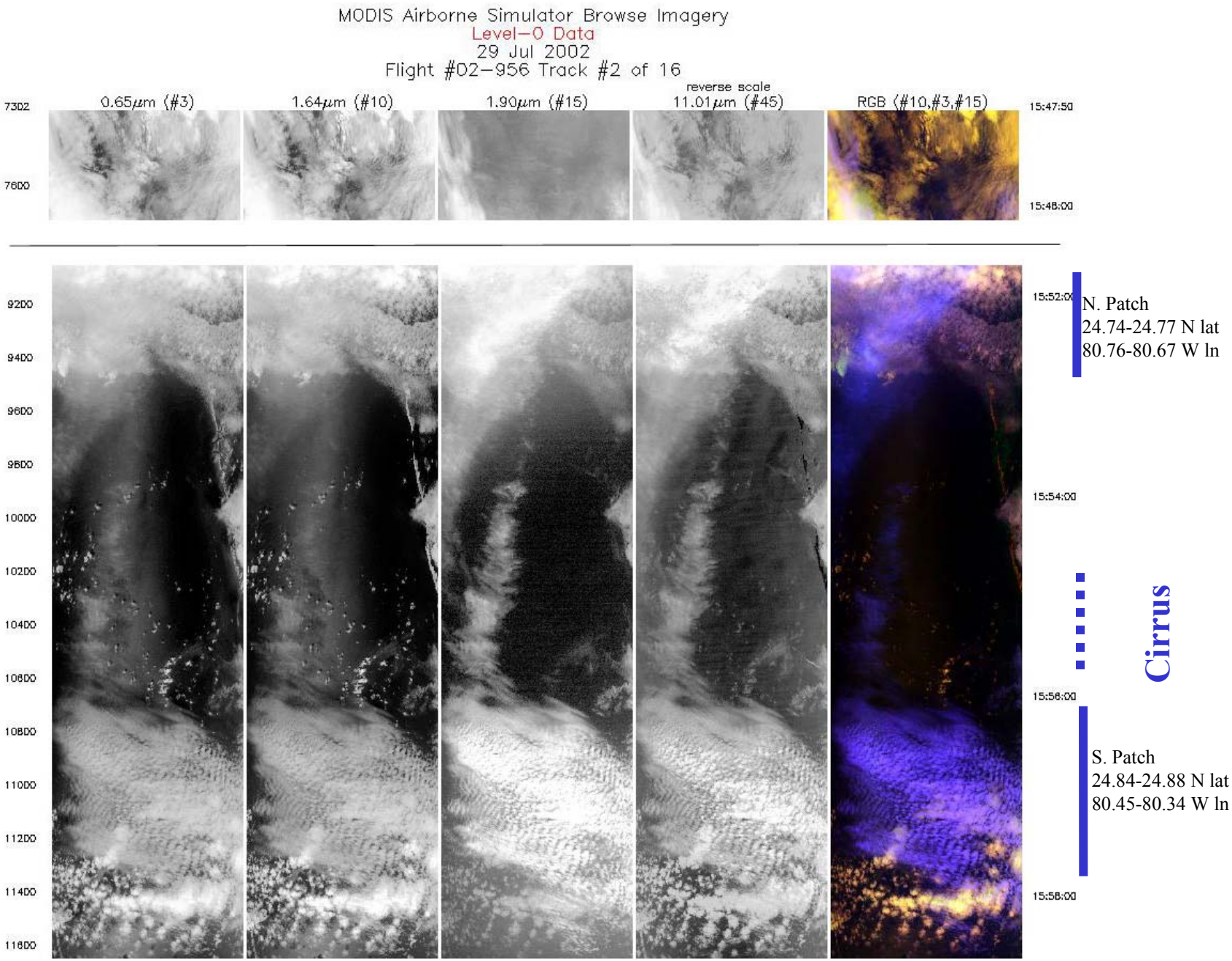


MISR AN
Nadir View
July 29, 2002

FLORIDA_EAST: Orbit 13897, Path 14 Block 69-73
July 29, 2002
MISR Level 1B2 TERRAIN RGB AN



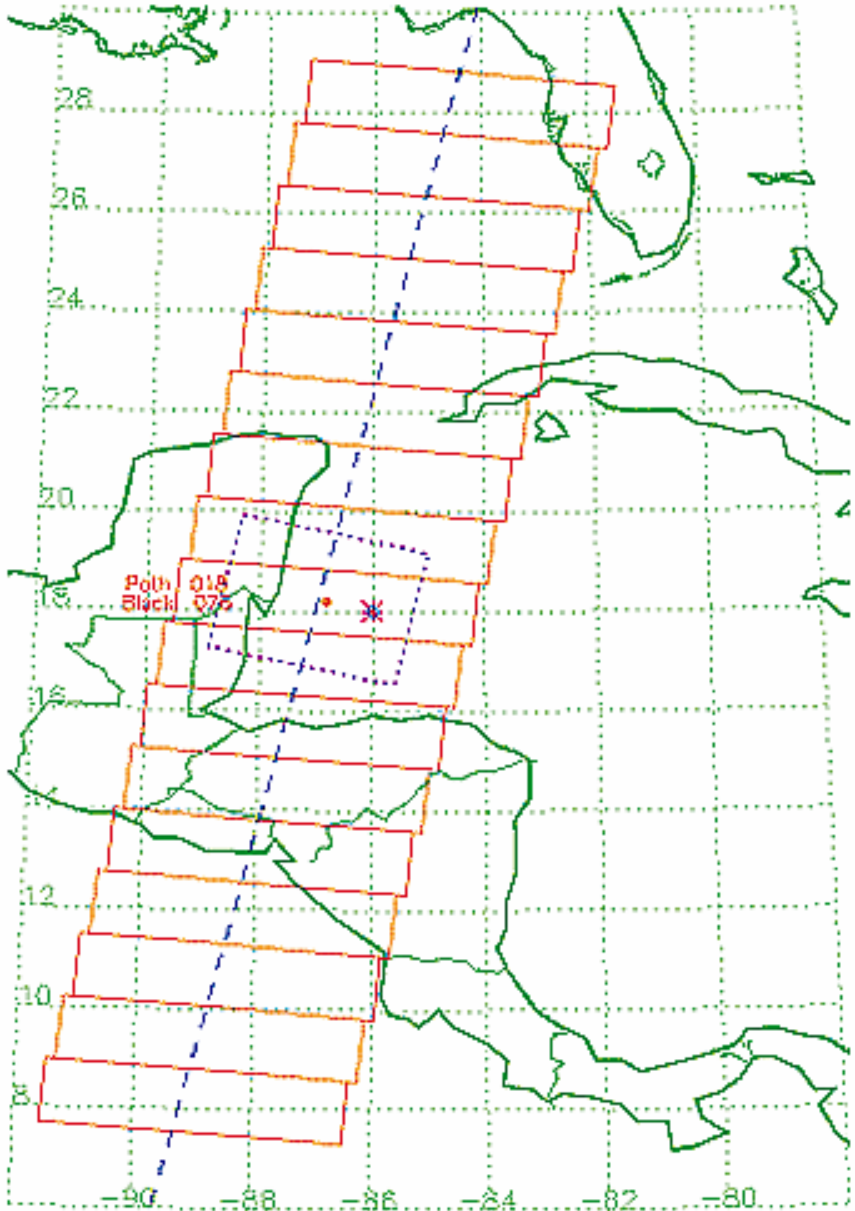
MAS: MODIS Airborne Simulator - ER-2



CRYSTAL_SW Site July 09, 2002 16:26 - 16:33 UTC

Path 18 Orbit 13606

paths over CRYSTAL_SW2, Local Mode Site #3021 (18.000, −86.

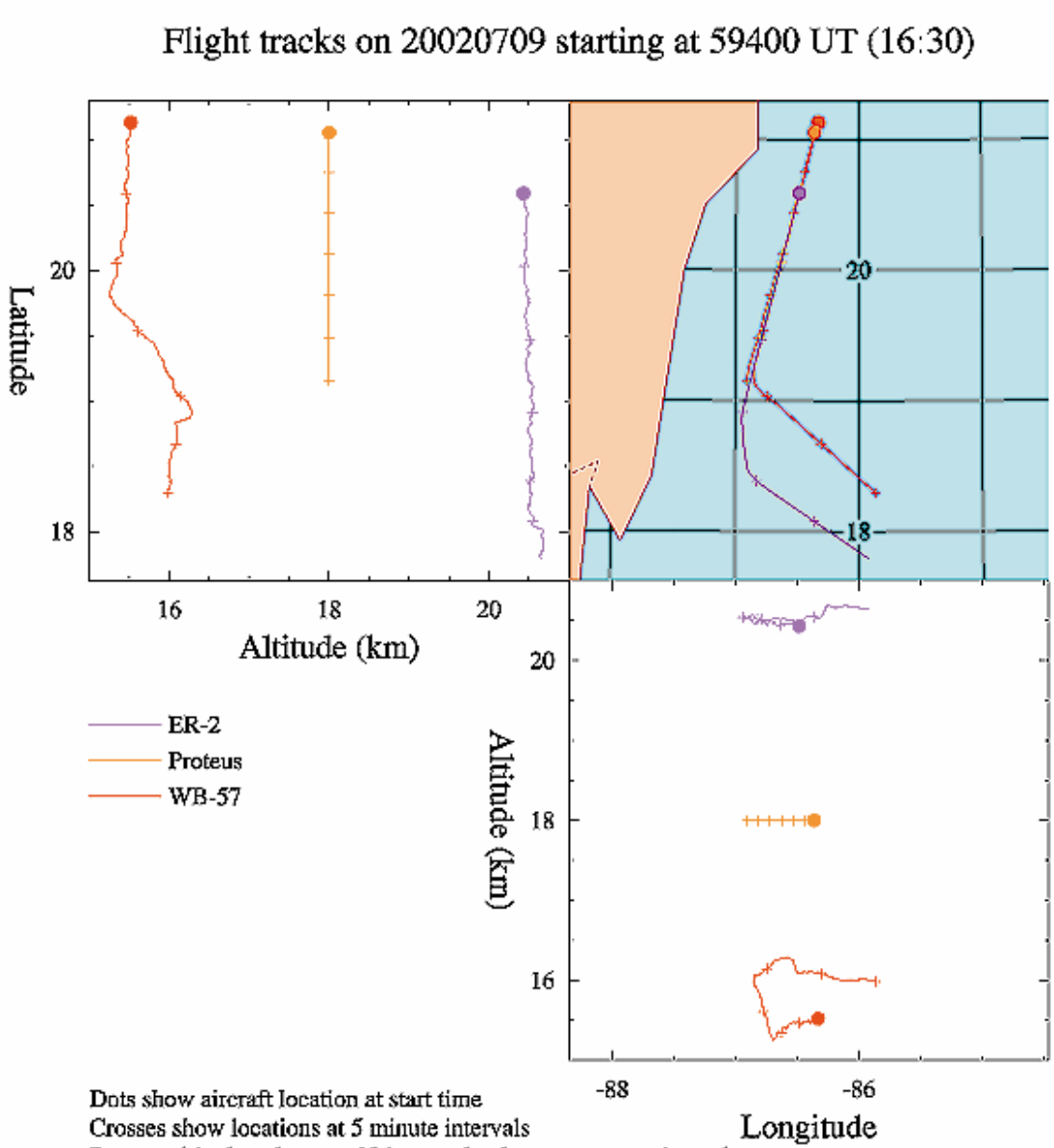


Path 018, Black 076

Orbit	X-Track	Df Time
13606	104.7 km	16:26:
13839	104.9 km	16:26:

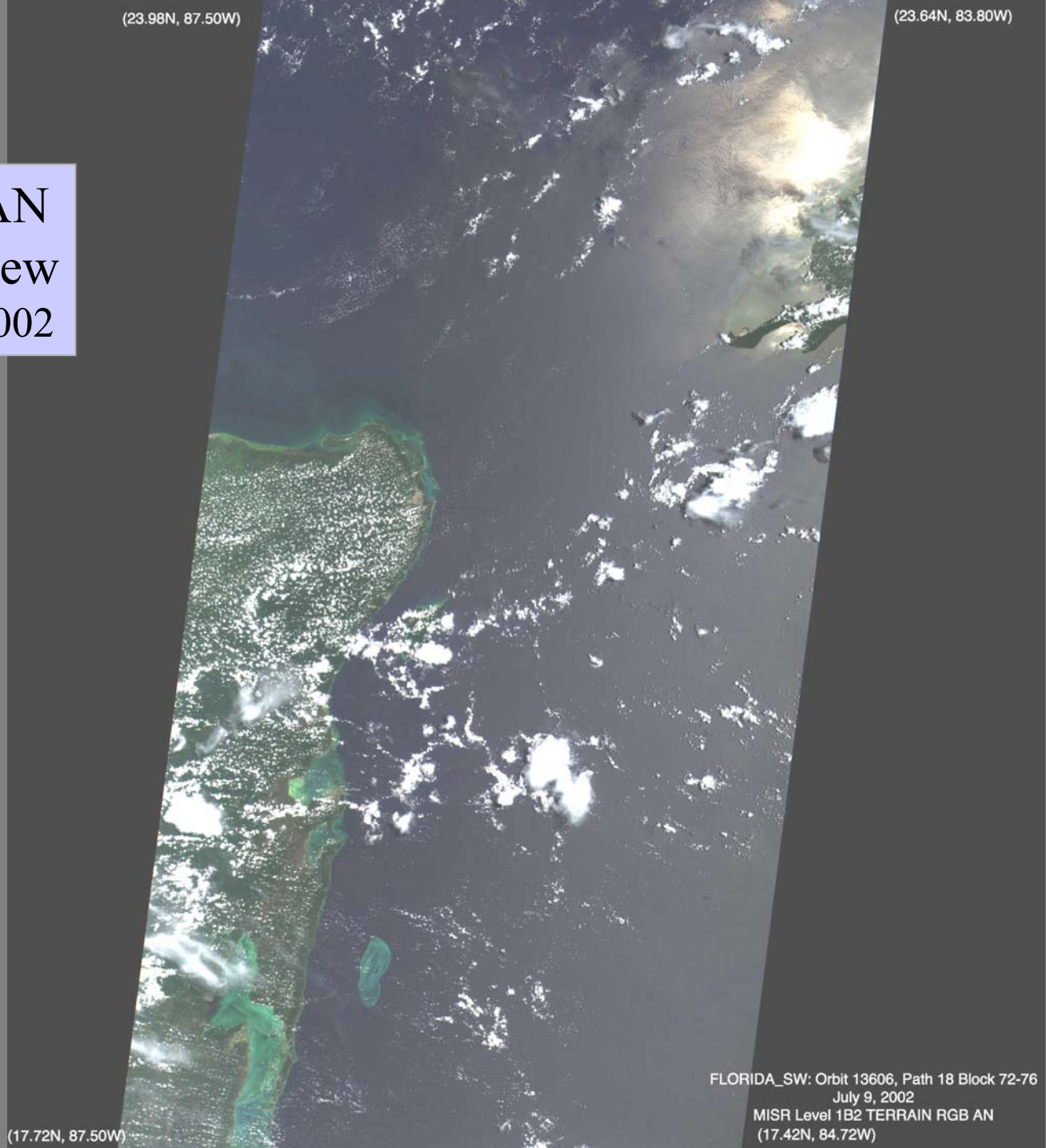
Nearby LM Sites

Flight tracks on 20020709 starting at 59400 UT (16:30)



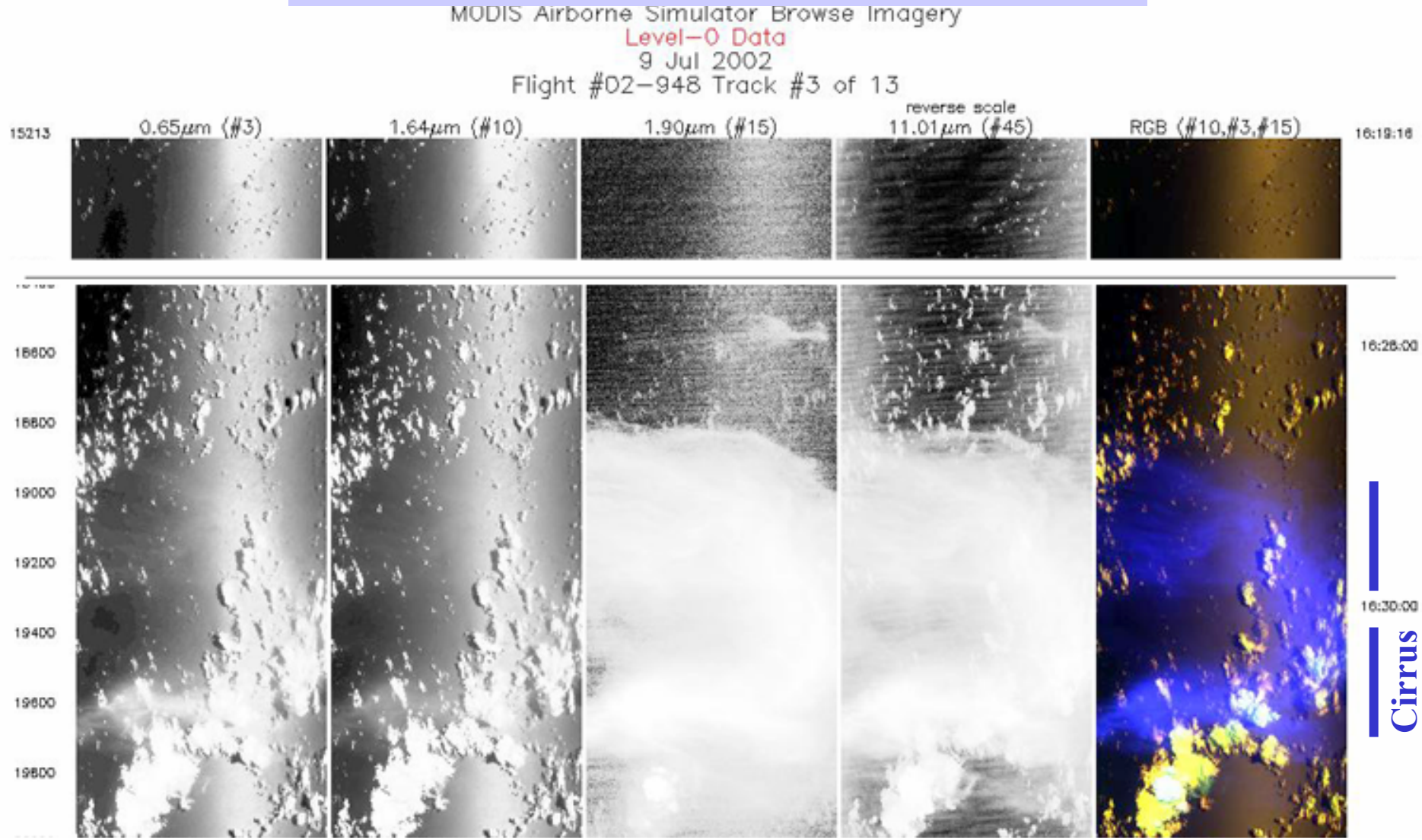
Dots show aircraft location at start time
Crosses show locations at 5 minute intervals
Proteus altitude unknown; 18 km used only as representative value

MISR AN
Nadir View
July 09, 2002



MAS: MODIS Airborne Simulator - ER-2

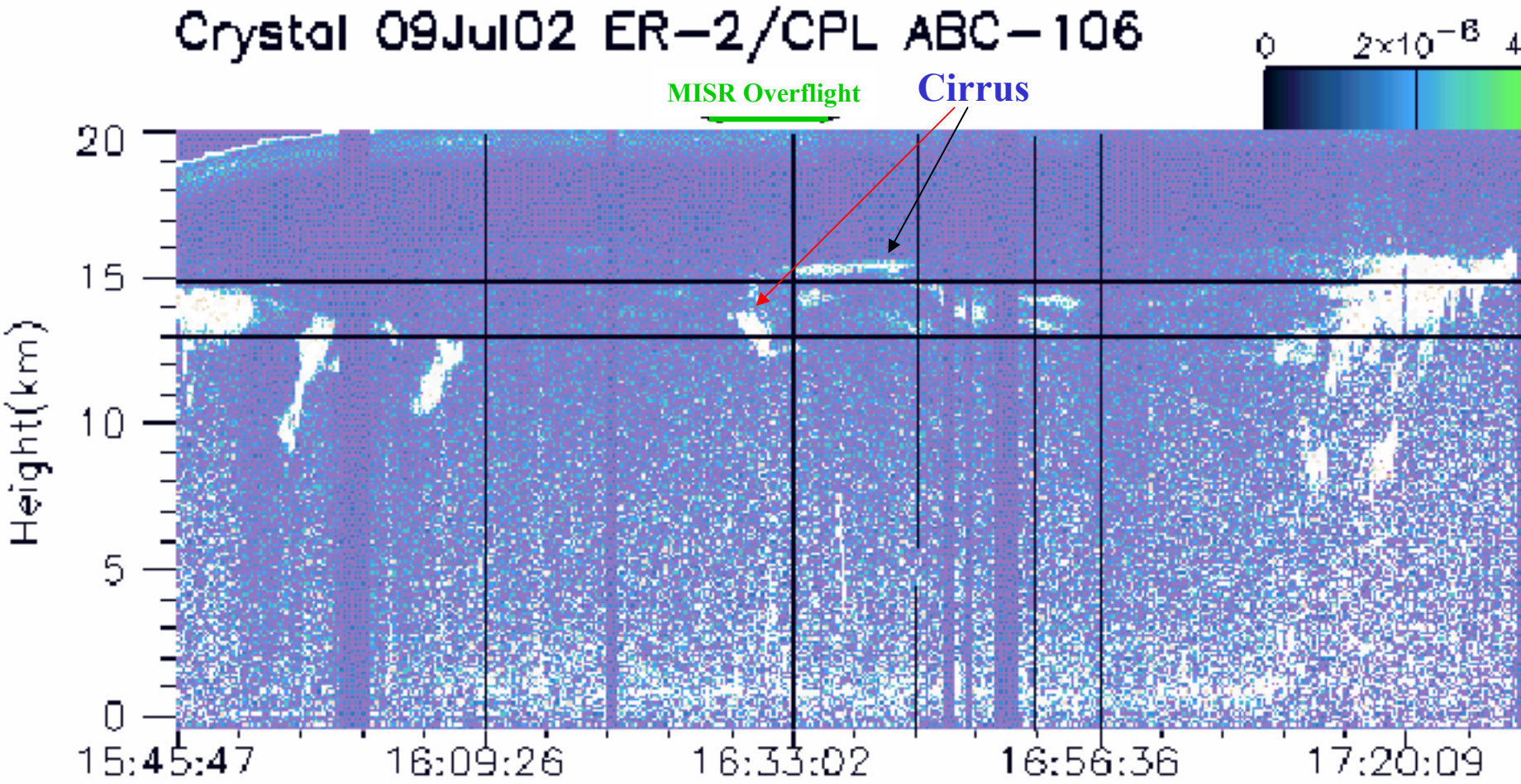
July 09, 2002

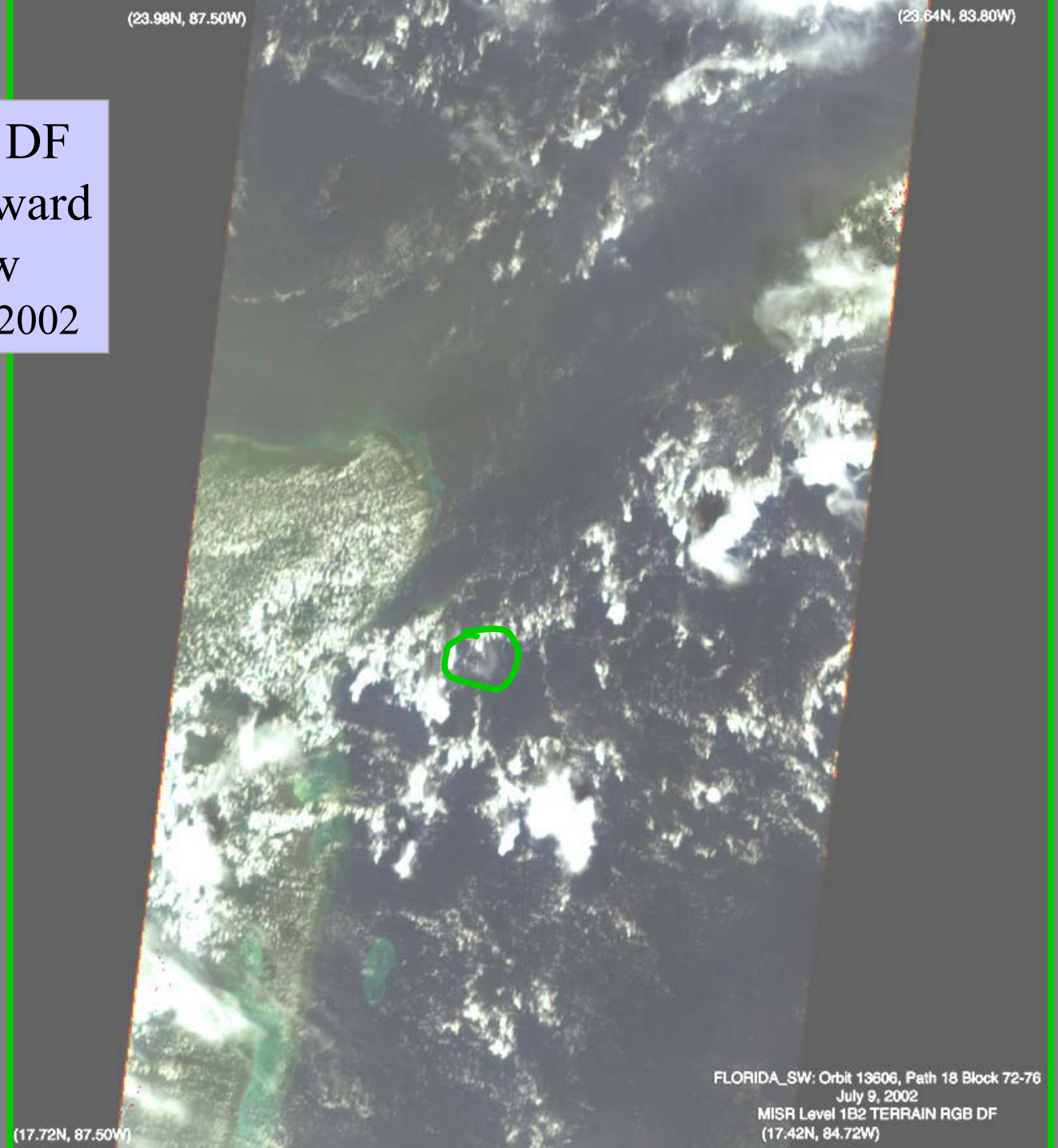


ER-2: 16:29 to 16:31 UTD; 20.70 to 20.48 N lat.; 86.45 to 86.51 W lon.; 20.39 to 24.45 km elev.

WB-57: 16:33:52 to 16:36:00 UTC [59632 to 59760]; 20.71to 20.48 N lat.; 86.45 tp 86.51 W lon; 15.47 to 15.45 km elev.

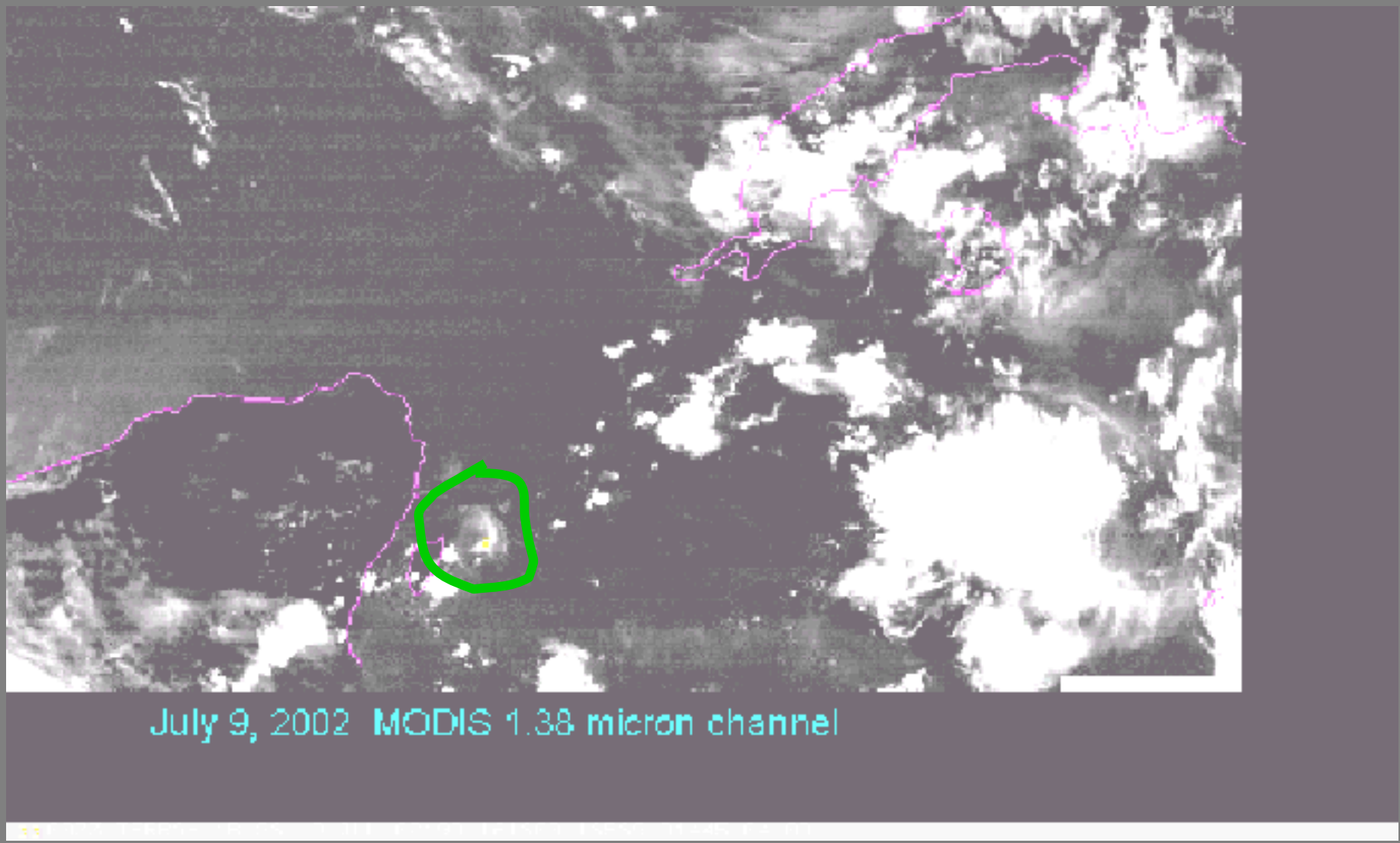
CPL: Cloud Physics LIDAR - ER-2



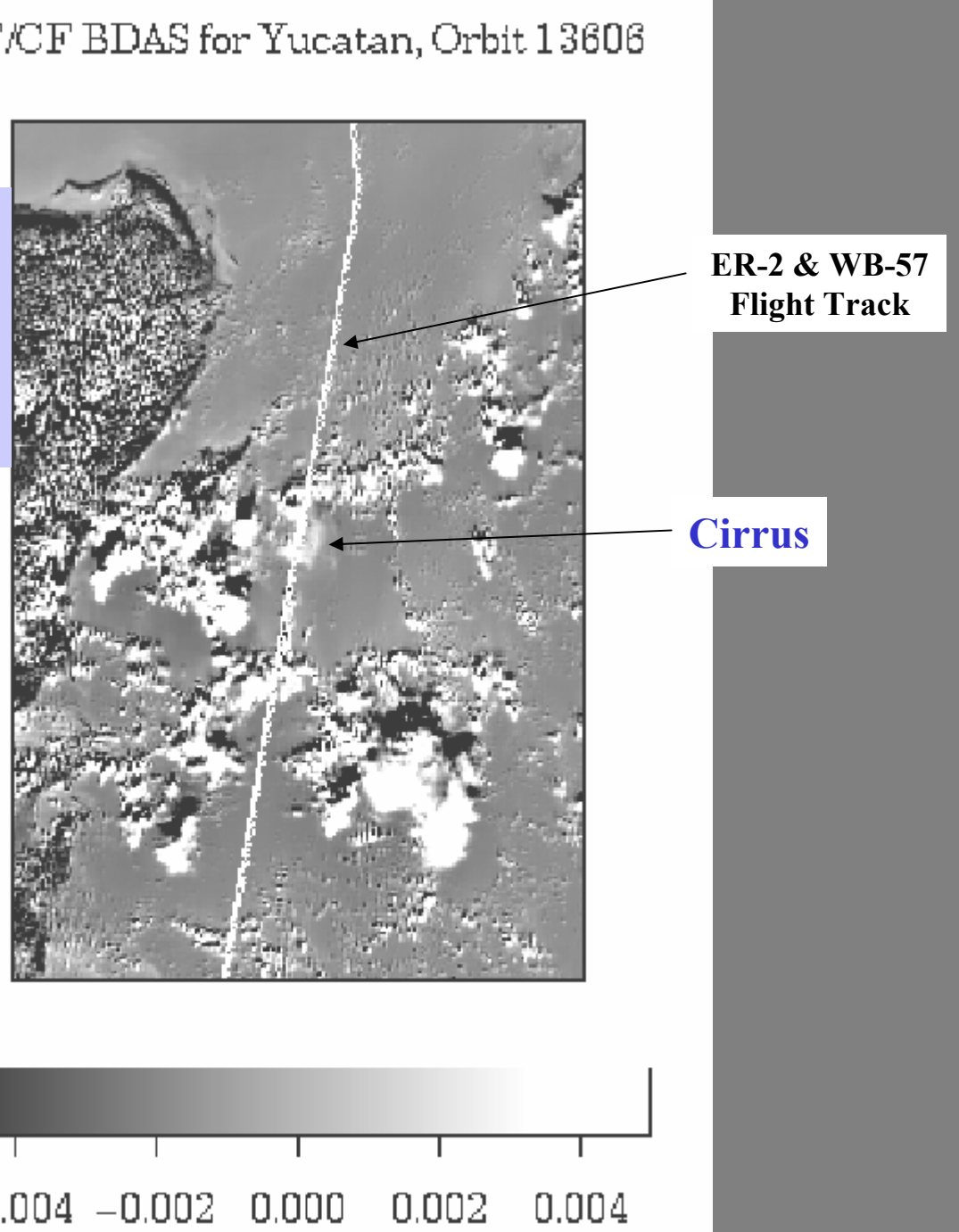


MISR DF
70° Forward
View
July 09, 2002

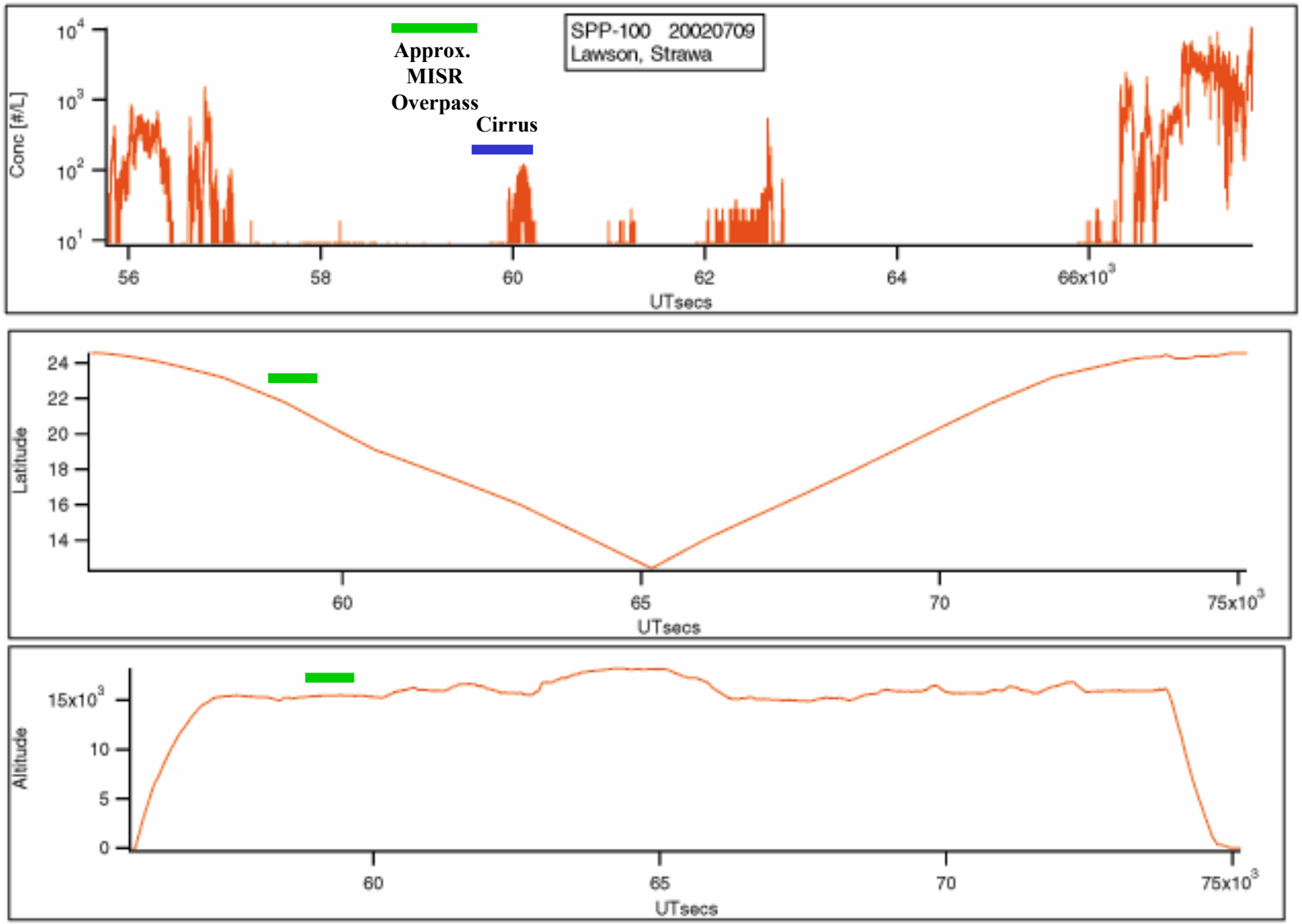
MODIS 1.38 Micron Cirrus Channel - Terra
July 09, 2002



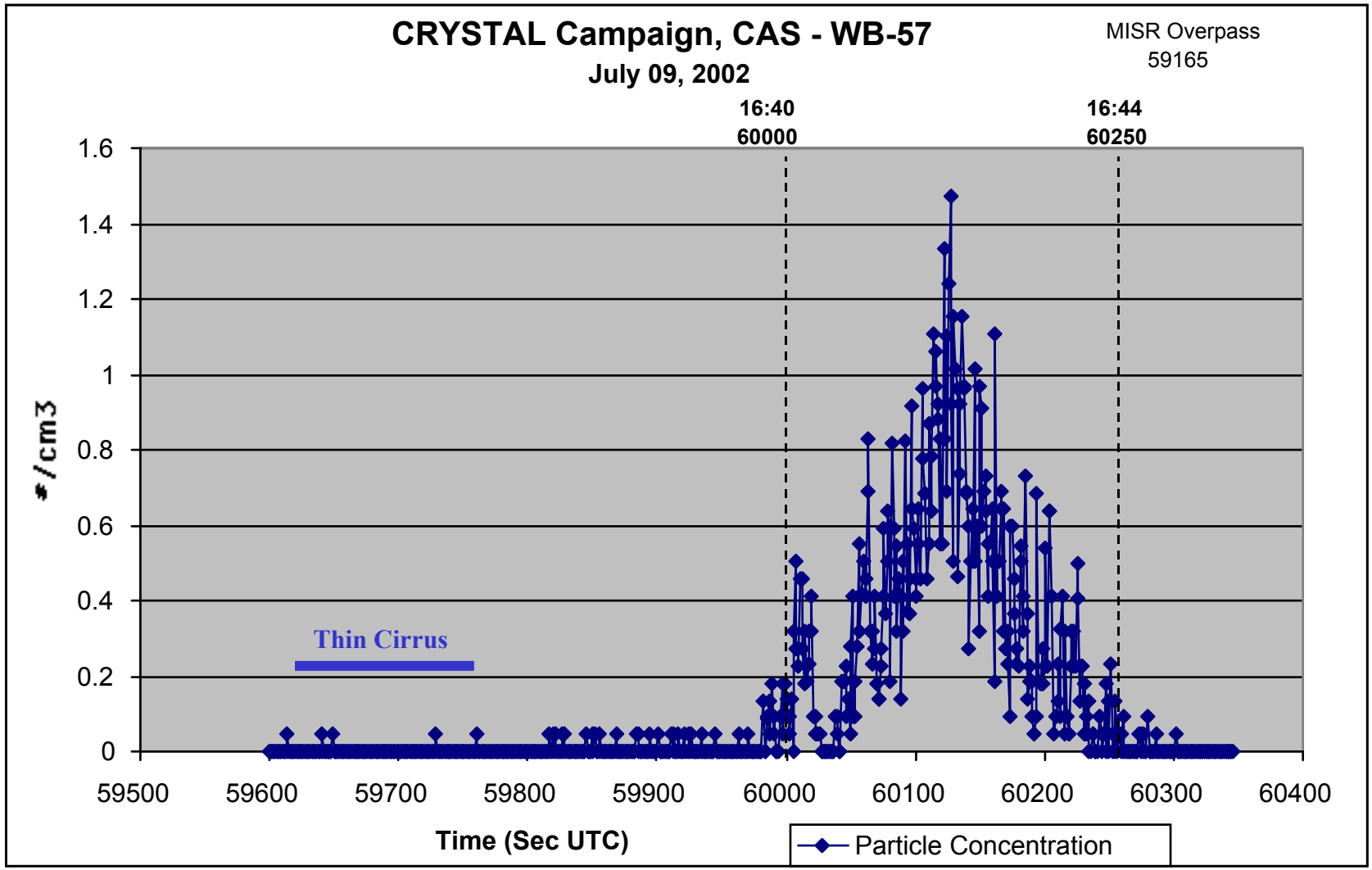
MISR **BDAS**:
Band-**D**ifferenced
Angular **S**ignature
(**Forward** C&D Cameras)



SPP-100: Forward Scatt. Spectrometer Probe, Signal Processing Package - WB-57
July 09, 2002

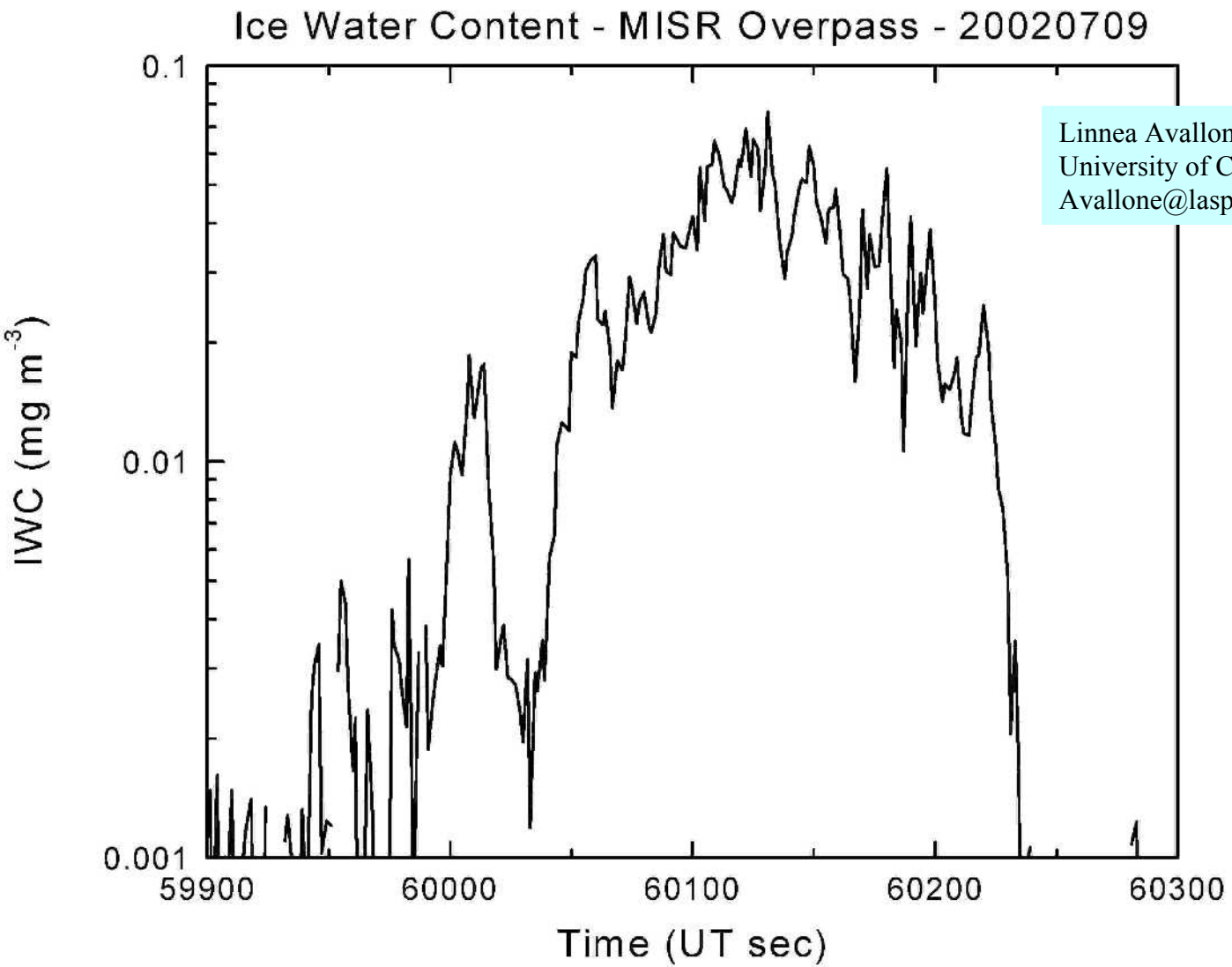


CAS: Cloud and Aerosol Spectrometer - WB-57



CLH: Closed-Path Laser Hygrometer - WB-57

July 09, 2002



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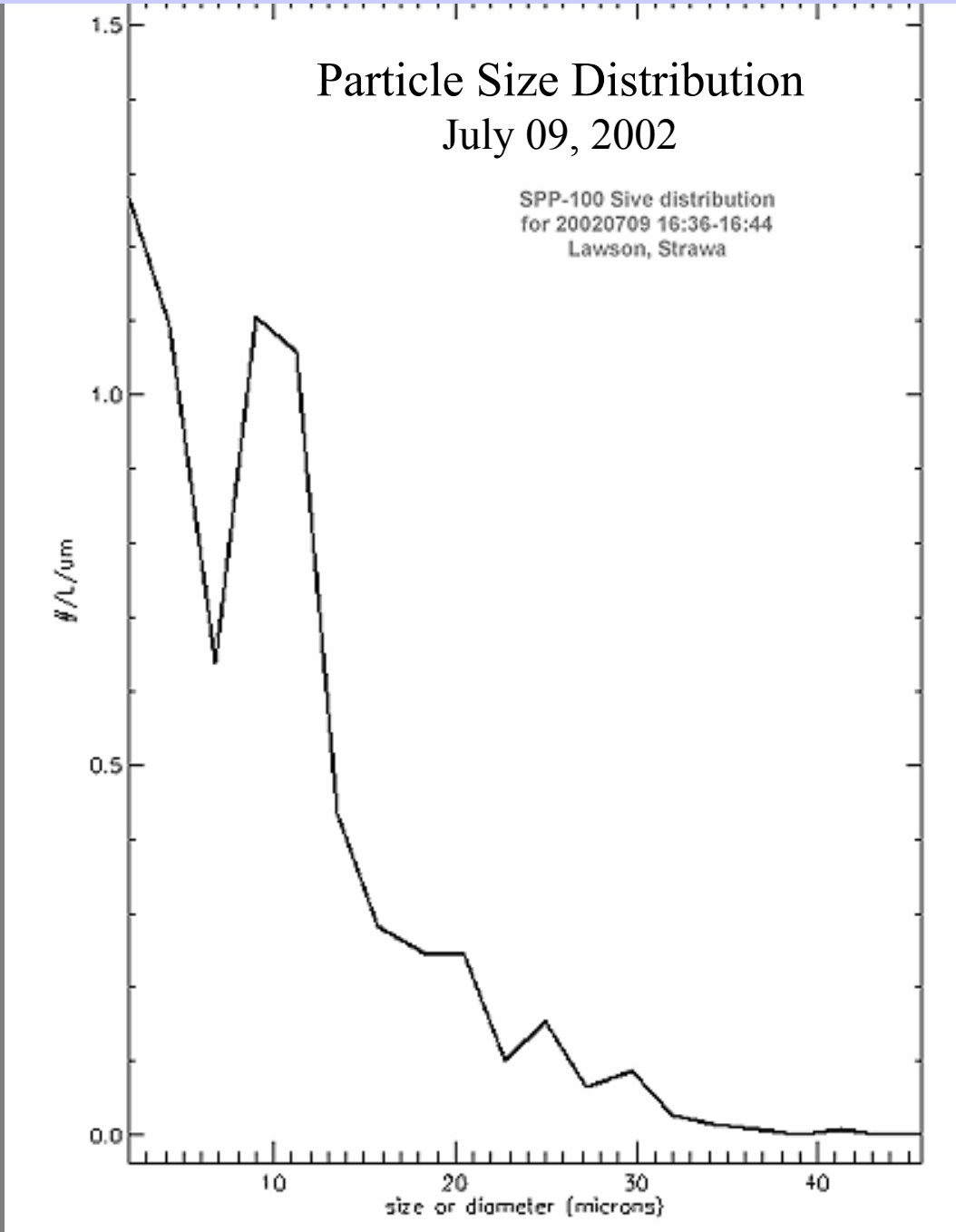
An upper bound on the Ice Water Content for the period 59632 to 59760 is about 0.003 mg m^{-3}

SPP-100: Forward Scatt. Spectrometer Probe - WB-57

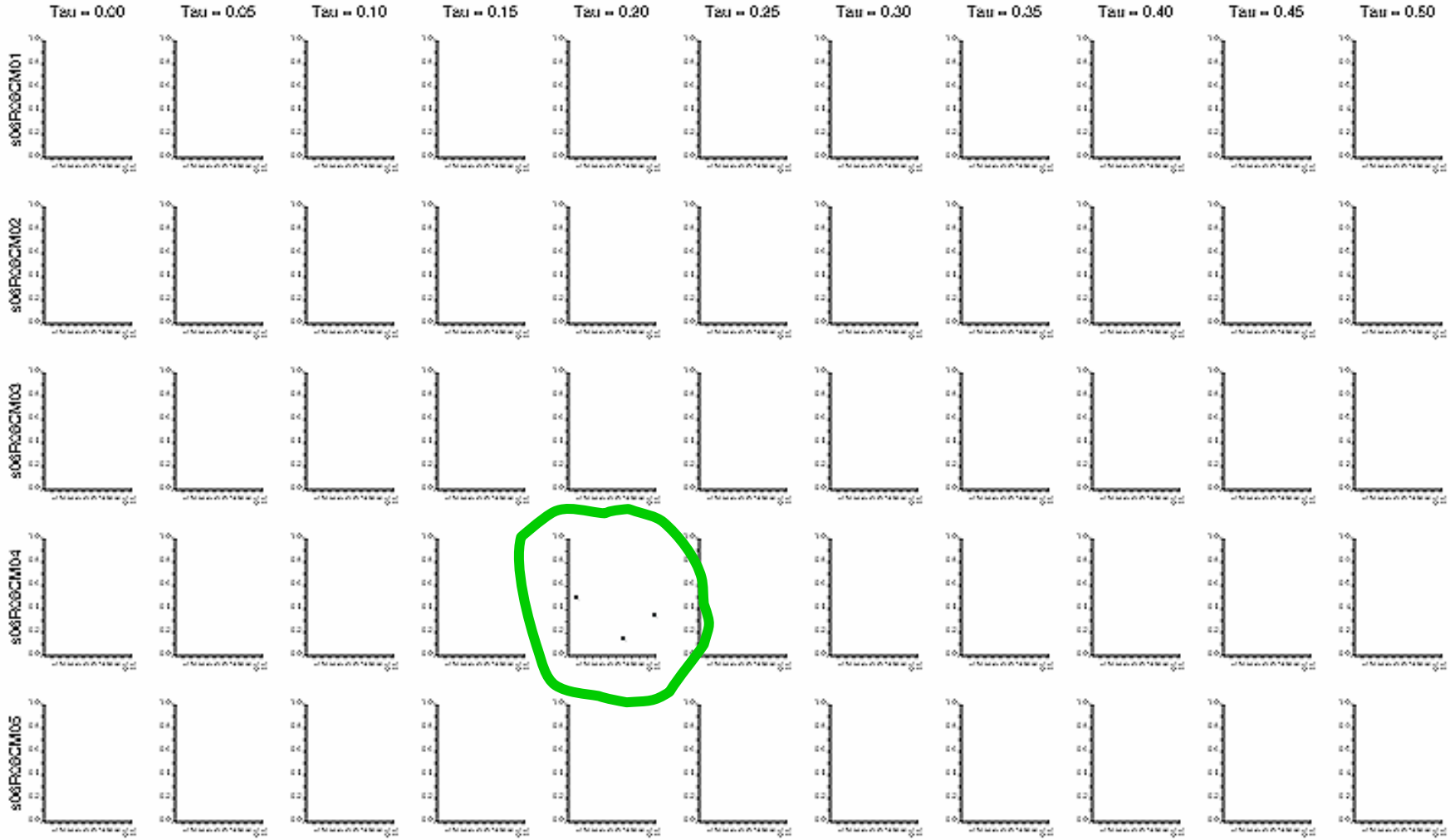


CPI: Cloud Particle Imager - WB-57

July 09, 2002

One Particle Collected between 16:36 and 16:44 UTC

MISR Research Aerosol Retrieval -- July 09, 2002

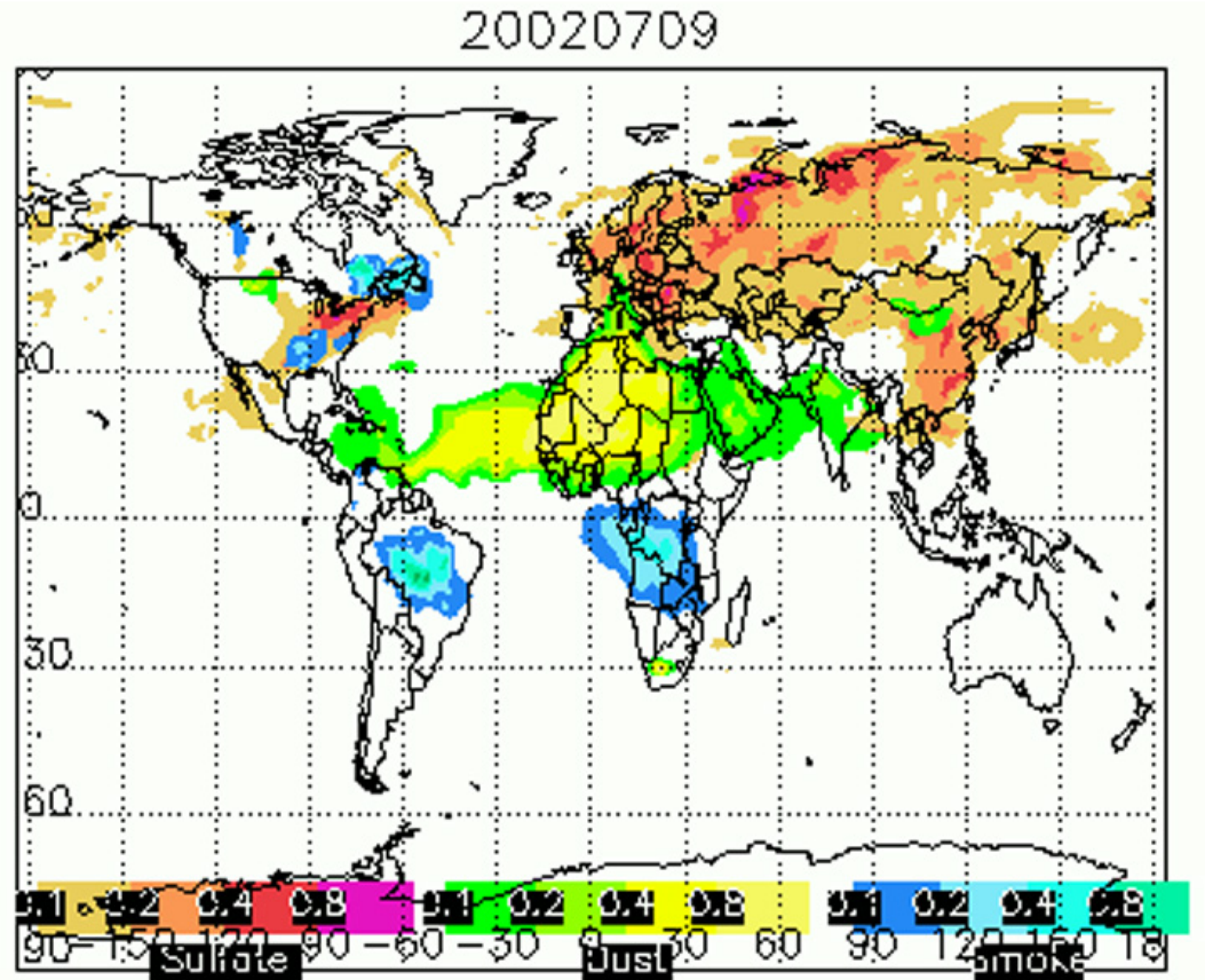


1 - spherical_nonabsorbing_0.06 (sulfate, sea salt, organic)
2 - spherical_nonabsorbing_0.12 (sulfate, sea salt, organic)
3 - spherical_nonabsorbing_0.26 (sulfate, sea salt, organic)
4 - spherical_nonabsorbing_0.57 (sulfate, sea salt, organic)
5 - spherical_nonabsorbing_1.28 (sea salt, organic)
6 - spherical_nonabsorbing_6.96 (water soluble)
7 - nonspherical_absorbing_1.18_lo (red dust)
8 - nonspherical_absorbing_1.18_hi (red dust)
9 - nonspherical_absorbing_7.46 (red dust)
10 - spherical_absorbing_0.04 (black carbon)
11 - thin_cirrus_hexagonal_columns_from_Mishchenko

AOT_{558} = 0.20; 50% small spherical non-absorbing; 15% dust; 35% cirrus

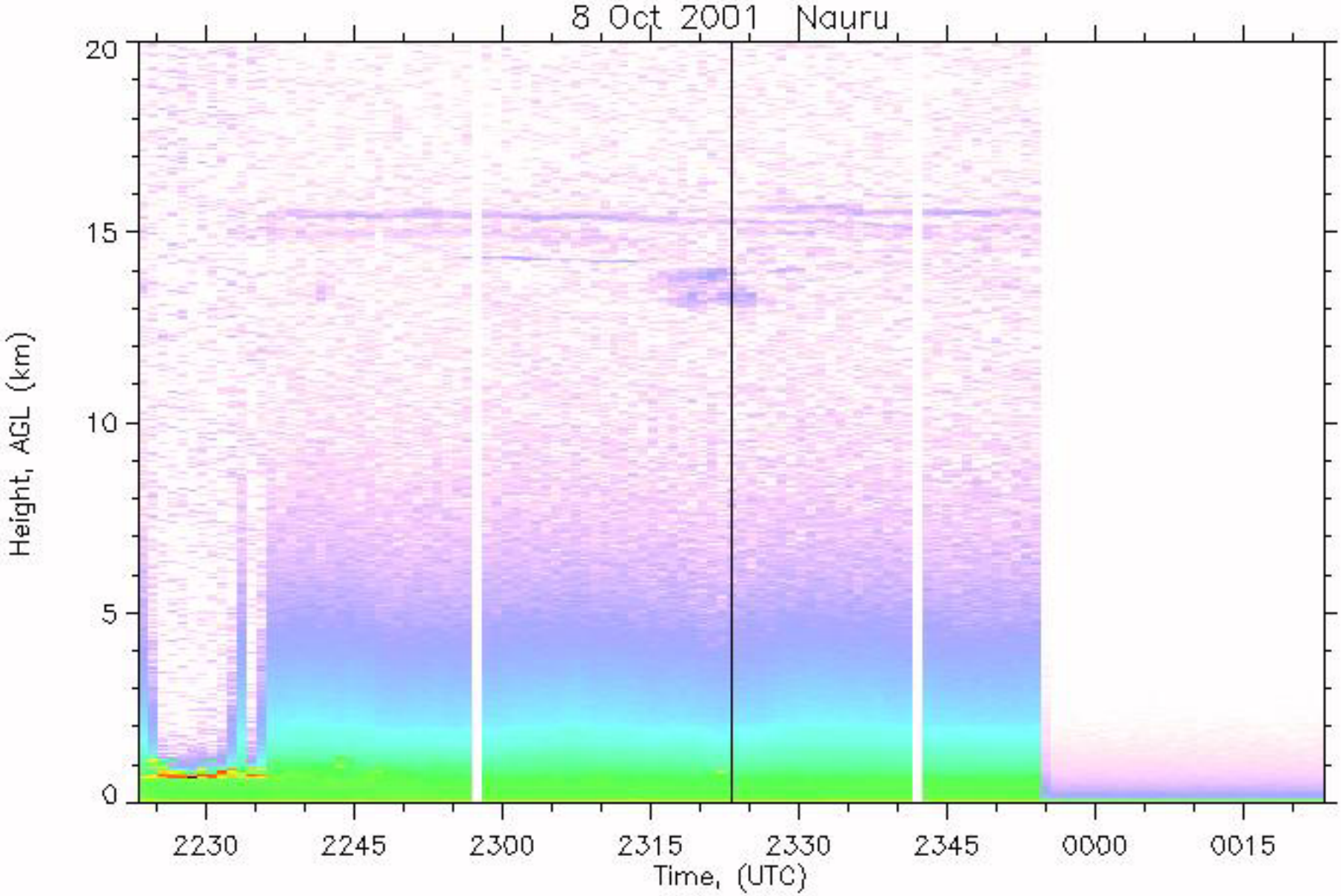
tau_water = 0.002, atm_stat_index = 2, windspeed_index = 1
File id: /data/science/explorer/dsm/local_mode_V2.2/crystal/13606/chisq/t2/s06/5x5/s06R08CM??337000333.bin chisq_max_3 = 5.701868975

Westphal Global Aerosol Model, July 09, 2002

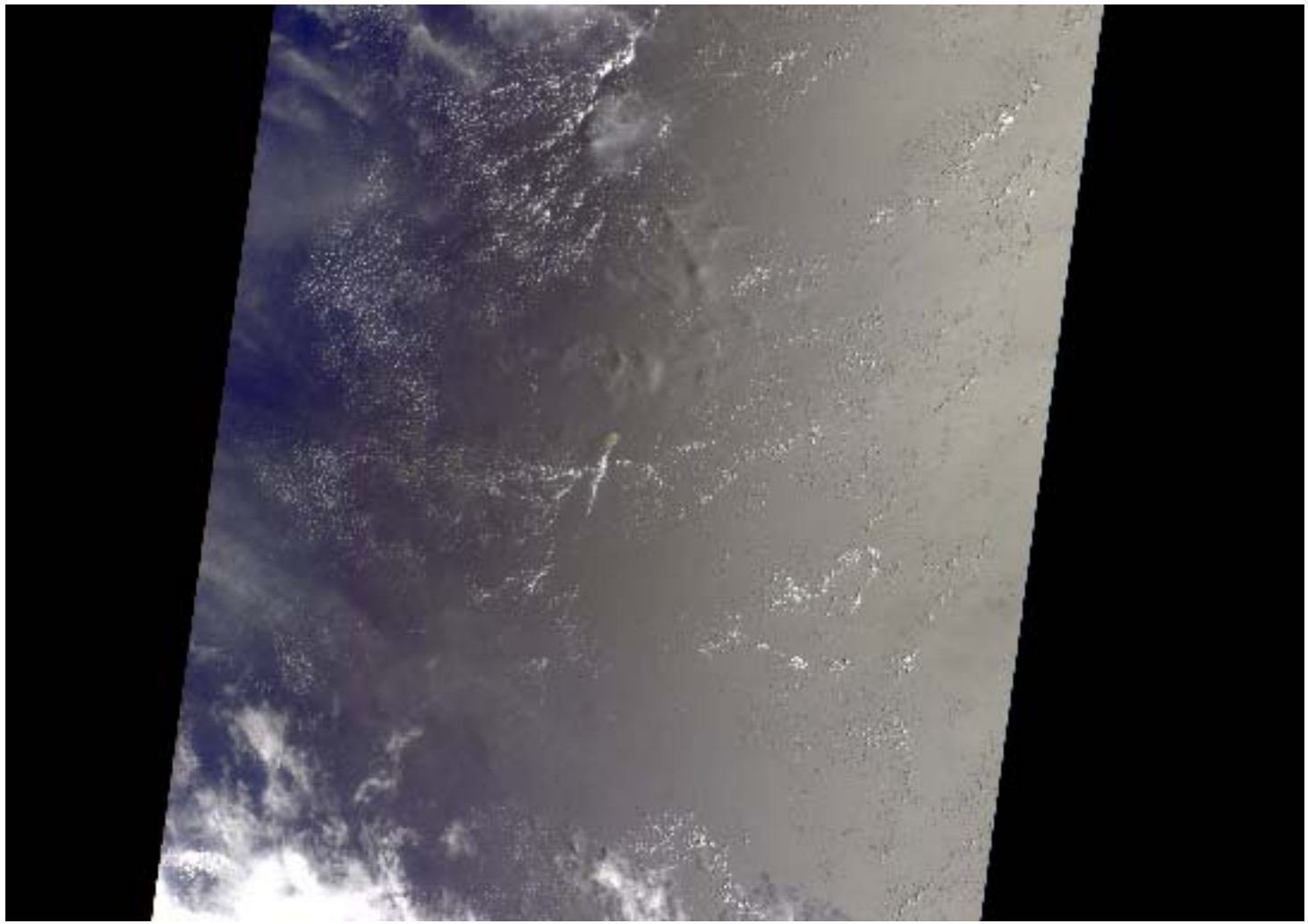


MISR - Nauru LIDAR Coincident Thin Cirrus Observations

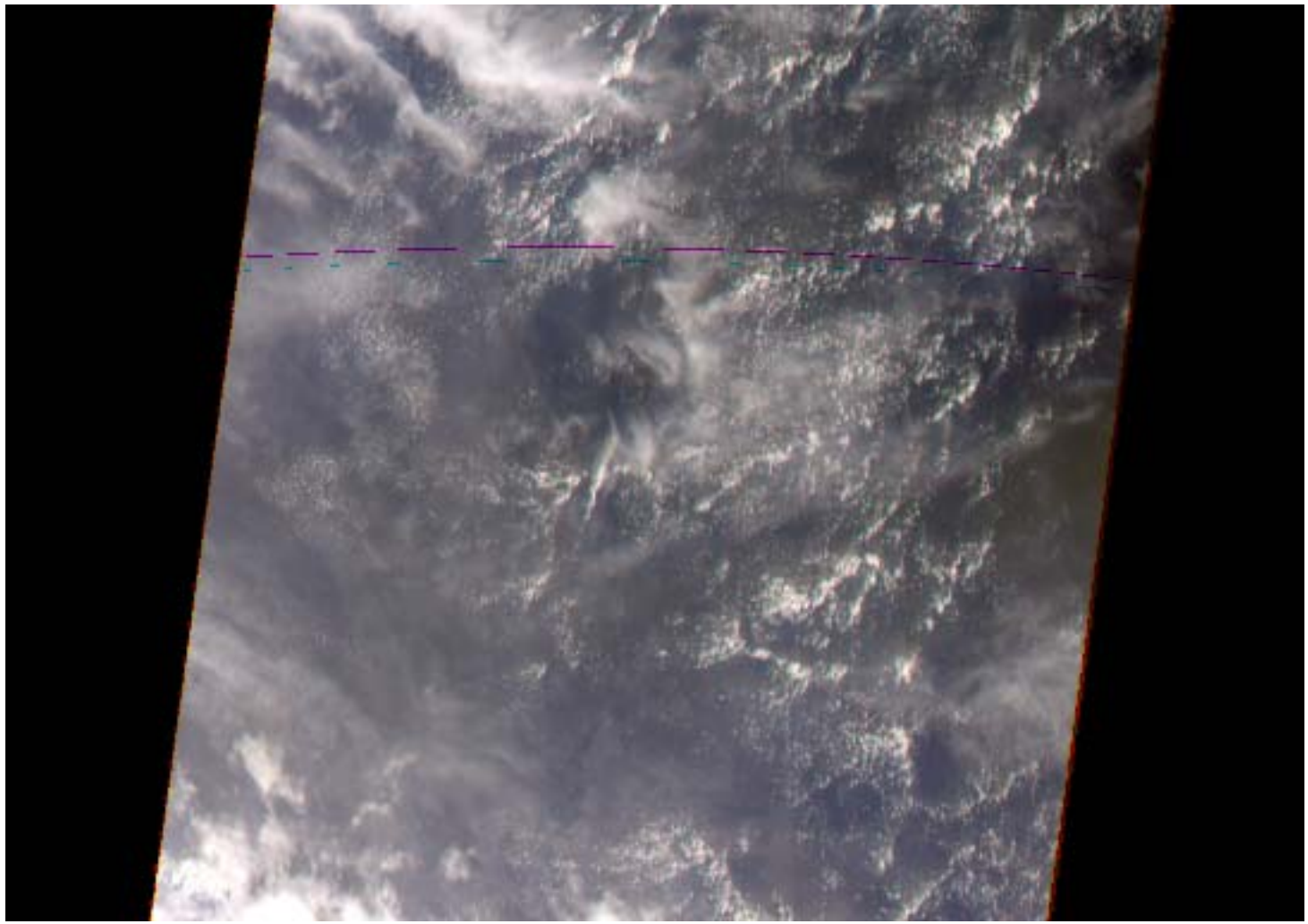
Date	DOY	MISR Time (UCT)	Orbit	Path	Cloud Base (km)	Cloud Top (km)	AOT_532	Notes
Nov. 29, 2000	354	23:36:22	5062	85	14.115	15.644	0.06	**Cirrus**
June 2, 2001	153	23:26:42	7756	84	13.709	14.278	0.047	**Cirrus**
Oct. 8, 2001	281	23:23:09	9620	84	14.327	15.508	0.097	**Cirrus**
Jan. 28, 2002	28	23:19:50	11251	84	10.271	12.367	0.509	**Cirrus**
Sept. 22, 2001	265	23:23:30	9387	84	13.319	13.619	0.022	**Cirrus**
Oct. 28, 2000	302	23:37:02	4596	85	0	0	0	Cloud-free
May 17, 2001	137	23:27:04	7523	84	0	0	0	Cloud-free
Oct. 24, 2001	297	23:22:38	9853	84	0	0	0	Cloud-free


8 Oct 2001 Nauru
Height, AGL (km)
20
15
10
5
0
2230
2245
2300
2315
2330
2345
0000
0015
Time, (UTC)

MISR L1B2 AN RGB Image October 08, 2001, Nauru, Orbit 9620 Path 84 Blocks 90-92



MISR L1B2 DF RGB Image October 08, 2001, Nauru, Orbit 9620 Path 84 Blocks 90-92



Where We're At…

- The CRYSTAL-FACE data demonstrates we **can coordinate aircraft and spacecraft** to study thin cirrus

- The July 09 analysis illustrates MISR's **ability to detect and retrieve cirrus AOT** in the presence of aerosols

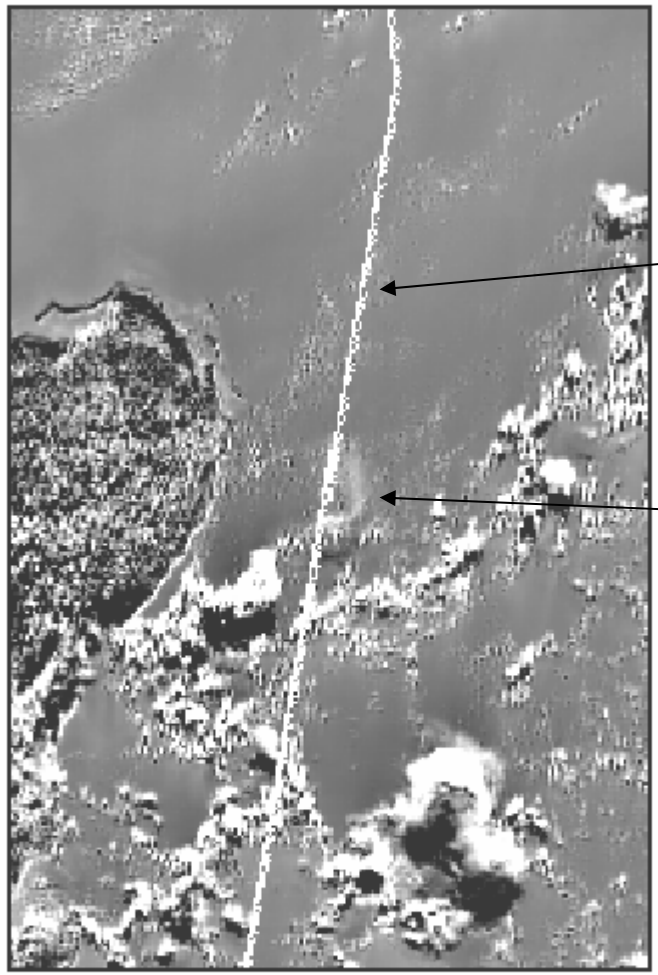
- The Nauru data set will help us **quantify MISR's sensitivity to cirrus AOT**

- More data will be needed to assess MISR **sensitivity to cirrus crystal habit**

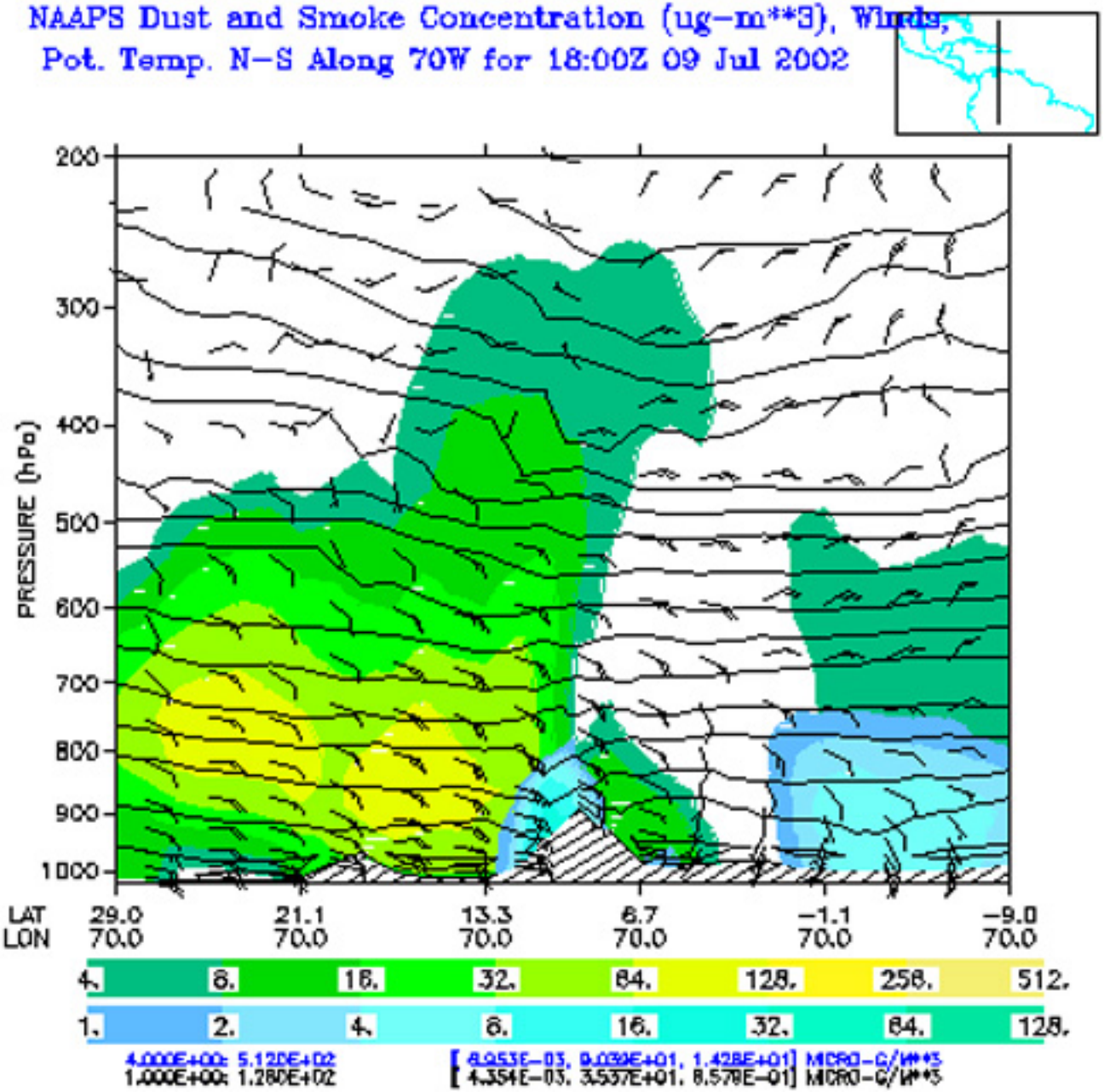
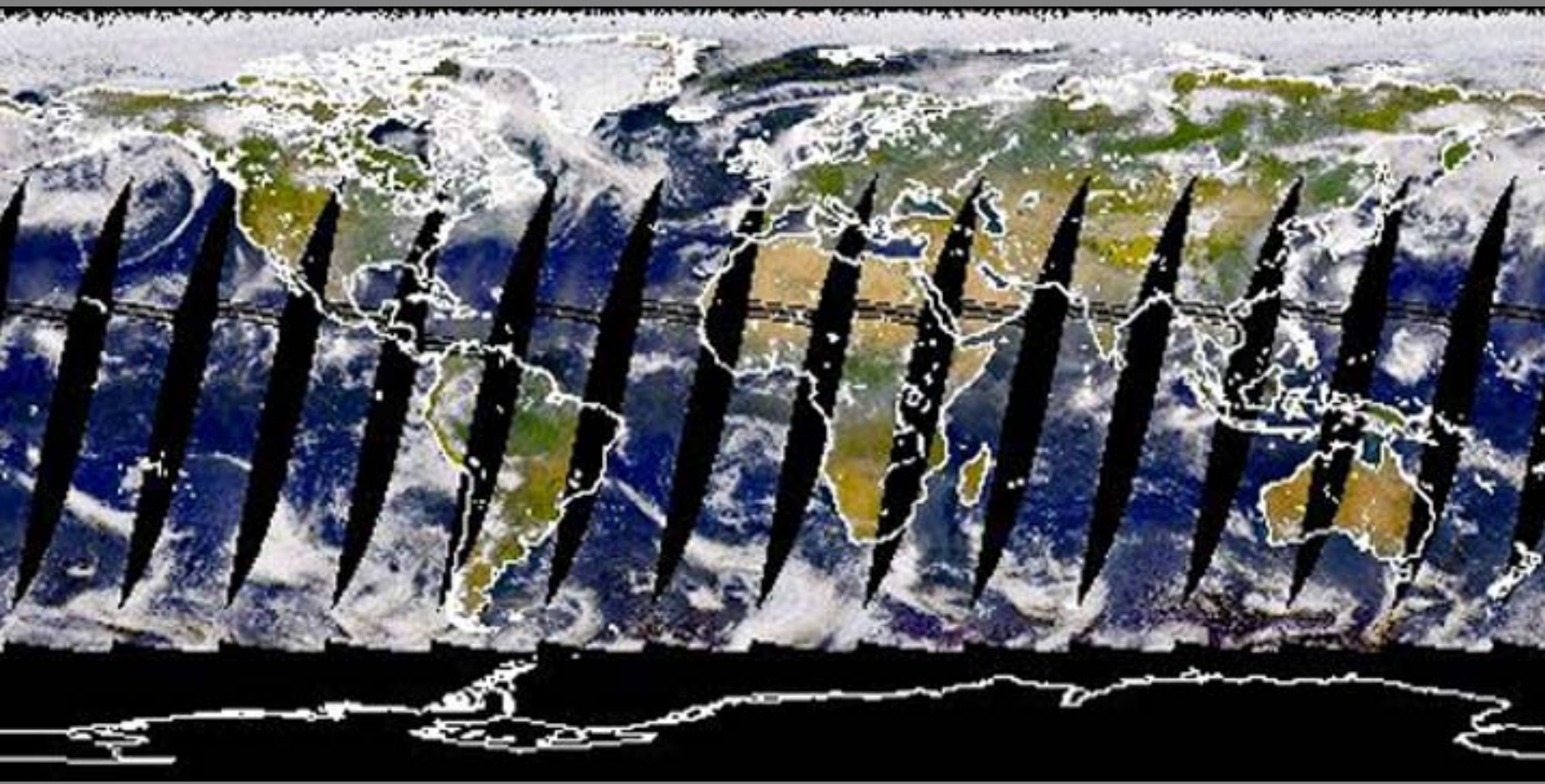
- We would like to test **a range of cirrus optical models in the MISR retrieval**

MISR **BDAS**:
Band-**D**ifferenced
Angular **S**ignature
(**Aft** C&D Cameras)

DA/CA BDAS for Yucatan, Orbit 13606



Westphal Model Dust (Vertical Slice) July 09, 2002



SeaWiFS Composite -- July 09, 2002